EXPLANATION OF PLATE X.

Figure 1. *Passiflora Pfordti;* Vöchting's dynamometer attached to tendr B, short arm, C, long arm, D, pointer, E, hook, F, scale, L, curve of long arm spring, N, iron post.

Figure 2. *Passiflora cærulea;* A, tendril carrying weight of nineteen gram slightly curved near base, B, tendril carrying weight of nine grams, spiral tip, C, tendril grasping tendril B, which it has pulled from the perpendicular

Figure 3. *Passiflora cærulea;* A, growing tip of shoot with undeveloped ten drils, B, tendril slightly sensitive and nutating, C, tendril capable of coiling tendril nearly mature—in the period of highest activity.

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## The limitation of the term "spore."

CONWAY MAC MILLAN.

Every one who has attempted to define his terms of dai use has probably met with the same experience that the writer might describe. Words, easily definable at first, be come more and more vague as their implication is more fu understood. In view of the scantiness of botanical termin ology, although it is one of the richest of scientific vocabu laries, there is great need that the import of common term should be examined with much care to avoid the errors of over-, or under-definition. Every work that appears prese some new and generally barbarous verbal technicalities th tend rather to cloud than to clarify perception. For exam in that most excellent little compendium on the cryptogam plants, lately published from Bennett and Murray, one grieved to find that the word "sperm," properly employed plant, as in animal, biology, is diverted to a peculiarly necessary meaning and is taken as a synonym of the phras "fertilized egg," when it would have been much preferable unify the terminology by calling the antherozoid of the pl a "sperm," and thus recognizing what it is necessary to r cognize as fully as may be that the animal and the plant alike, for the higher groups of organisms, in producing sex cells and that these cells are, even in their intimate mitotic ph nomena of development, strictly analogous, if not absolute homologous.

At present I wish to speak in particular about the use the word "spore" in botanical writing, and it is not inten to offer any historical or highly exhaustive discussion at th time, but simply to show how under the general term the are a number of ideas that clear thinking demands should kept separate. In the first place it may be noted that th term spore is not used here as having any connection with the so-called "oospores" of the books, for they are surely better given some other name, since they are products of gametic union. The same may be said of the "zygospores" of the Conjugatæ. The word is therefore limited here under the well known definition, "a spore is an originally perfect cell specialised for purposes of reproduction."

Nor is it intended to examine the various categories of spores which present in their terminology some idea of their formation, as for example the æcidiospores, sporula, chlamydospores, conidiospores, sporidia, teleutospores, ascospores, etc., of the mycologist. The word is to be taken only in its general sense. It will be seen however, that clear definition demands that the spore shall have some phylogenetic limitation as well as the ordinary morphological or physiological or embryological limitation. It thus happens that one is compelled to examine the course along which the higher types of spores have developed. It will then appear that the use of the word in different orders of plants is always with a group of reservations peculiar to the particular plant, or series of plants, in question.

The spore appears in its generalized form in such plants as the bacteria and among low algæ, such as the Protococci, the Chroococci or Palmellaceæ. Here it is a cell which must be defined by setting it over against the ordinary vegetative cell of its plant. In *Bacillus anthracis*, for example, the spore is but little different from the ordinary cell and may be limited very properly by considering it an ordinary cell in which such slight specializations as have appeared are directed towards the withstanding of temperature changes and other external influences that might be dangerous if not made the basis of an adjustment. Such spores as these may be considered as generalized and basal, and may for the purposes of this classification be known as *primospores*.

In the well known *Ulothrix*, and in plants above, but near its plane we find that the primospores become themselves a subject for further differentiation and they function either as spores or as gametes, in the lower plants of this division, while in the upper the specialization is perfected to heterogamy. In Ulothrix and its allies, then, the spore is not only to be set over in contradistinction to the ordinary vegetative cell but it is also limited from the imperfect reproductive cells, the gametes, and thus acquires a new meaning. Spores of this type may be termed here *secundospores.*

In *Œdogonium* the sporophytic structures emerge. The well known facts of Œdogonium life history need not here be detailed. It will be remembered that the fertilized egg undergoes rejuvenescence and segments into usually four spores motile and similar to the spores of the gametophytic generation which are themselves of the secundospore type. The spores thus formed as the result of sporophytic segmentation may be distinguished very well under the name of *tertiospores*. They are characteristic of the Œdogonium series and are more generalized than other sporophytic spore structures.

Passing to *Riccia* and its allies, we encounter the fourth type of spore, from the point of view of this classification. In Riccia the segmentation of the fertilized egg proceeds until a structure is developed that consists not only of spores but of enclosing, protective and more or less vegetative cells. In this case, the reverse process to that observed in the lower plants has taken place. Instead of spores emerging from the modification of vegetative cells one finds vegetative cells tracing back to spore cells. Indeed, therefore, the whole vegetative system of higher plants may be considered as developed from a series of reproductive cells as seen in Œdogonium, while in the series below the emergence of the sporophyte the spore cells must be considered as an emergence from the more generalized type of cell which is at once reproductive and vegetative. Such spore cells as those of Riccia, since they must be defined as developed with the by-cells of the segmentation, are to be held in contradistinction with the vegetative sporophytic structures. Such spores, following the terminology, may be known as *quartospores.*

While bisexuality of gametophytic plants may originate without a preliminary morphological differentiation of the spore, as for example in *Equisetum*, nevertheless it happens that the sex of the plant to be produced from the spore may be predetermined not only in the inner activities of the spore but in its size, shape and general structure. In this way heterospory appears and we discover in such excellently investigated plants as *Pilularia, Isoetes* or *Selaginella* among the so-called cryptogams and in *Taxus, Lilium* or *Narcissus* among the so-called phanerogams a predetermination of the sex of the plant to be produced, long before the spore that is to produce the plant is itself mature. In cases like the whether it be the pollen spore of the composite, the embryo-sac-spore of *Casuarina* or the less modified heterospore of *Marsilia* or *Azolla* or *Isoetes*, it becomes impossible to define the spore without attention to the sexual *potentiality* of the cell and the function of its plant-product that is to be the result of germination. Such spores as have undergone this profound morphological differentiation with regard to the sex of the plant to be produced from them may be given the name of *quintospores*.

It seems clear that in the great lines of development of the vegetable kingdom there are these five types of spores to be distinguished one from another. To each of them the term *spore* is ordinarily applied but, as I have attempted to show, with a widely different implication in each case. The word *spore*, then, in the Bacteriaceæ stands for a very different structure than does the same word in the Compositæ. It may be objected that this is but to transfer new ideas into the word and thus make it more difficult to comprehend. The objection is hardly well taken, I think, for it is evident that the analysis does not read anything into the word that has not already, by common consent, been included in its meaning.

Of the five phylogenetic types of spores, if I may name them so, the first two belong to the plants below the sporophytic emergence. It is remarkable that these types of spores, so fully represented low in the scale, are so completely lost as one passes higher. In Œdogonium both secundospores and tertiospores are formed, but in the gametophyte of the Muscineæ, only a short distance above, they seem to be wanting. The suggestion might be made that the propagative cells of the archegoniate gametophyte may be the representatives of the secundospores of Œdogonium. Gemmæ of *Marchantia* or *Tetraphis* might be thus homologized and would then either appear to be multiple spores like those of some of the fungi, as *Macrosporium* or *Cladosporium*, or would be the result of a development from an original spore-cell. In any case the view here indicated, that the persistence of the secundospore would be a fruitful study, may be productive of some results. Again, the notion that the vegetative cells of sporophytic structures may be traced back to tertiospores, gives some additional light, it may be, upon the high degree of vegetative propagation, so-called, that goes on in higher sporophytic structures. Vegetative development being the acquired state of the cell it would be possible to explain the propagative activity that often makes itself apparent even in highly specialized organs, as the leaf of the Begonia, by the laws of reversion, and vegetative propagation would become atavistic in its implication. Entirely apart, however, from speculations like these it seems well to insist upon the close examination of even so common a term as the word "spore," for any increase in exactness is an impetus to thought that should not be underestimated.

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## The range of variation in species of Erythronium.

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WITH PLATE XI.

About a year ago while working upon plant variations some interesting variations of *Erythronium Americanum* were found of which I could find no record. During the past two years I have made a careful study of the two species, *E. Americanum* and *E. albidum*, with the view of ascertaining the limits of their variations. Over four hundred specimens have been examined, and the results seem to warrant publication.

According to the best authorities the principal specific differences of the two species lie in the stigmas and color of perianth; E. Americanum having an entire, club-shaped stigma, while the stigma of E. albidum is three-cleft and spreading. In the fifth plant of E. Americanum that I examined the stigmas were not united; they were $3.2^{mm}$ in length with a spread of $3^{mm}$, and of fifty-three plants of which I took careful measurements, only seven had the stigmas united, the length of the stigmas ranging from $1.3^{mm}$ to $7.1^{mm}$. As may be seen in figs. 1–3, the stigmas of E. Americanum are not recurved; fig. 10, on a much larger scale, shows this more clearly and also shows the contracted appearance just below the apex; measurements for the spread of the stigma were taken above this at line *a;* these measurements range from $1.3^{mm}$ to $3.6^{mm}$.

Owing to the curve of the stigma of E. albidum, it was impossible to take accurate measurements of the length; there is, however, a considerable range, although not as great as in E. Americanum. The spread of the stigma of this species